MASTER OF SCIENCE
IN
MECHANICAL ENGINEERING

EFFECTS OF SHORT CRESTED SEAS ON THE MOTIONS OF A TROLLEY INTERFACE FOR SHIP-TO-SHIP CARGO TRANSFER
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This thesis sets out to explore the effects on the dynamic response of a hybrid trolley system employed in ship-to-shore cargo transfer operating in a realistic short crested irregular seaway. Compared to the uni-directional long crested waves, the multi-directional nature of short crested waves enhances the realism of the modeling. A standard cosine-squared spreading law was added to the two-parameter Bretschneider spectrum. The results provide added data on the coupled system response in all directions and moderate any overestimation that may be derived from simply using long crested waves.

KEYWORDS: Short-crested Seas, Trolley Interface, WAMIT, Cosine Spreading Function, Wave Energy Dispersion, Bretschneider Spectrum, Motion Analysis

FINITE ELEMENT ANALYSIS OF THE HIERARCHICAL STRUCTURE OF HUMAN BONE
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The objective of this study was to develop an analytical model of the basic hierarchical structure of the human bone. The model computed the stiffness of composite collagen fibers comprised of collagen fibrils and hydroxyapatite mineral crystals. Next, the stiffness of the concentric lamella was computed utilizing the stiffness of the collagen fibers and layer information. Finally, the effective stiffness of the bone was estimated. In order to determine the stiffness of the collagen fiber, a three-dimensional finite element model was developed and a simple analytical model was derived. The simple analytical model was validated using the finite element results. The lamination theory of uni-directional fibrous composites was used to calculate the stiffness of the lamella and eventually the bone stiffness. A series of parametric studies were conducted to understand what parameter(s) affected the stiffness of the bone most significantly. This information will be useful when an artificial bone structure is designed.

KEYWORDS: Finite Element Analysis, Finite Element Model, Human Bone Modeling, Bone Structure, Lamination Theory

SHIP SHOCK TRIAL SIMULATION OF *USS WINSTON S. CHURCHILL* (DDG81): SURROUNDING FLUID EFFECT
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The *USS WINSTON S. CHURCHILL* (DDG-81) shock trial was conducted in May and June 2001 off the coast of Naval Station Mayport, Florida. Because the *USS WINSTON S. CHURCHILL* best represented

the new line of Flight II-A Arleigh Burkes, it was chosen to undergo ship shock trials for its class. These trials are necessary in order to evaluate the vulnerability and survivability of the hull and the mission essential equipment in a "combat shock environment." However, shock trials are very expensive, require extensive planning and coordination, and represent a potential hazard to the marine environment and its mammals. Computer modeling and simulation are showing themselves to be a plausible alternative in investigating the dynamic response of a ship under these shock trial conditions.

This thesis investigates the use of computer ship and fluid modeling, coupled with underwater explosion simulation, and compares it to actual shock trial data from the *USS WINSTON S. CHURCHILL*. Of particular concern in this study is the amount of fluid that must be modeled to accurately capture the structural response of a full ship finite element model. Four fluid meshes were constructed and used to study the ship's response to an underwater explosion. Each simulation data was analyzed to determine which mesh best represented the actual ship shock trial results.

KEYWORDS: *USS WINSTON S. CHURCHILL* (DDG81), Ship Shock Modeling and Simulation, Fluid Mesh, Truegrid, LS-DYNA, USA, Underwater Shock Analysis, Underwater Explosion

SEAKEEPING ANALYSIS OF SMALL DISPLACEMENT HIGH SPEED VESSELS

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In developing designs for high speed vessels, the engineer must account for the response of the ship in the environment, while operating at mission essential speeds. This thesis presents a seakeeping analysis of David Taylor Model Basin's Series 64 models scaled to a 2500-ton displacement, using the SHIPMO and MATLAB software. It also discusses the current technology associated with high speed vessels (HSVs) and the relation to the U.S. Navy. Series 64 models provided the benchmark for resistance data. To expand upon this well known series, this research develops seakeeping data trends for scaled-up models. SHIPMO allows the user to specify the ship's characteristics and the environmental conditions, such as wave specifications and spectrum. Using the output files from SHIPMO, the MATLAB program designed during this thesis produced contour plots for the models' response in pitch and heave. Seakeeping trends were observed, based on the plots, and further compared to calculations of the seakeeping rank, R, a formula originally developed by Nathan Bales. The results of the research can be used by engineers in application to the design of small displacement, high speed ships, both monohulls and multi-hulls.

KEYWORDS: Seakeeping, High Speed Vessels, HSV, Series 64, SHIPMO

INITIAL STUDIES OF STRUCTURAL COUPLING EFFECTS FOR A TROLLEY/ROLL-ON ROLL-OFF DISCHARGE FACILITY INTERFACE

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The purpose of this thesis is to lay the foundation for analyzing structural coupling effects for a proposed trolley interface between a ship and a Roll-on Roll-off Discharge Facility (RRDF). Such a facility could allow heavy cargo transfer at higher sea states. Previous studies have analyzed motions assuming that there is no structural coupling between the trolley and the RRDF. A mathematical model that incorporates structural coupling is developed using the principle of virtual work. In order to assess the degree of necessity for the proposed model, a systematic series of numerical experiments is conducted. In these calculations, the trolley is modeled through a generalized stiffness coefficient and its influence on RRDF motions is assessed. It is shown that modeling of structural coupling may be necessary, depending on the relative order of magnitude of trolley structural rigidity and trolley placement.

KEYWORDS: Structure Coupling, Trolley, RRDF, Assumed Modes, Virtual Work